Bureau of Land Management

Reno, Nevada

Air Quality Modeling For BLM Vegetation Treatment Methods

Final Report

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1.0 INTRODUCTION

The U.S. Department of Interior Bureau of Land Management (USDI BLM) is proposing a program to treat vegetation on up to 6 million acres of public lands annually in 17 western states in the western U.S., including Alaska. The primary objectives of the proposed program include fuels management, weed control, and fish and wildlife habitat restoration. Vegetation would be managed using five primary vegetation treatment methods: prescribed fire, mechanical, manual, biological, and chemical.

The BLM is preparing a *Vegetation Treatments Using Herbicides Programmatic Environmental Impact Statement* (PEIS; USDI BLM 2005a) and *Vegetation Treatments Programmatic Environmental Report* (PER; USDI BLM 2005b) to evaluate proposed vegetation treatment methods and alternatives on lands managed by the BLM in the western U.S., including Alaska. The PEIS and PER will serve to update four EISs developed by the BLM in the mid-1980s and early 1990s.

The purpose of this report is to provide modeled concentration estimates of particulate matter for typical, but hypothetical ("example") emission scenarios for each of the five treatment methods at six representative locations throughout the western United States. Dispersion modeling was used to determine the predicted concentrations of TSP (total suspended particulates), PM_{10} (particulate matter less than 10 microns in diameter), and $PM_{2.5}$ (particulate matter less than 2.5 microns in diameter). Predicted concentrations were then added to a representative rural background concentration for comparison with National Ambient Air Quality Standards (NAAQS) to predict whether any of the treatment methods would contribute to any NAAQS violations.

Section 2 of this document describes the general dispersion modeling approach, including model selection, meteorological data processing, and the development of receptor grids.

Section 3 provides details regarding the example modeling of certain hypothetical short-term particulate emissions for each treatment method, using the modeling procedures discussed in Section 2.

Section 4 of this document discusses and interprets the modeling results.

2.0 GENERAL DISPERSION MODELING APPROACH

2.1 Selection of Dispersion Model and Meteorological Data

The United States Environmental Protection Agency's (USEPA's) guideline air quality California Puff (CALPUFF) air pollutant dispersion model (referenced in Appendix W of 40 CFR Part 51) was used to provide example predictions of potential particulate matter (TSP, $PM_{10,}$ and $PM_{2.5}$,) impacts of five vegetation management methods at receptors located between approximately 1 and 100 kilometers (km) from the assumed center of the modeled treatment areas (although the nearest receptors were placed 0.5 km from the edge of the treatment area in each case). Both 24-hour and annual impacts were predicted. CALPUFF "lite" version 5.5 was selected because of its ability to screen potential air quality impacts within, as well as beyond, 50 km and its ability to simulate plume trajectory over several hours of transport based on limited meteorological data.

The six modeling locations selected by BLM for the example assessments are:

- Fairbanks International Airport, Alaska
- Tucson International Airport, Arizona
- Glasgow International Airport, Montana
- Winnemucca Airport, Nevada
- Medford/Jackson County Airport, Oregon
- Lander/Hunt Field, Wyoming

These locations were selected as representative of various regions of the western states addressed by the PEIS and PER. For each of these six locations, 1 year of surface meteorological data from the Solar and Meteorological Surface Observation Network (SAMSON) data set that has been produced by National Climatic Data Center (as described online at http://nndc.noaa.gov/?http://ols.nndc.noaa.gov/plolstore/plsql/olstore .prodspecific ?prodnum=c00066-CDR-S0001) was used. After a review of available data, the most recent SAMSON year with complete surface and mixing height data was selected for each station. The SAMSON data set is particularly applicable for CALPUFF modeling because it contains hourly values of relative humidity and solar radiation, which are needed for chemical transformation calculations. Mixing height data for these sites were obtained from USEPA's "Technology Transfer Network Support Center for Regulatory Air Models" (available at: http://www.epa.gov/ttn/scram/).

CALPUFF was used in the screening mode, where meteorological conditions are assumed to vary from hour-to-hour, but are uniform throughout the modeling domain for each hour. In addition, since specific treatment locations are unknown, the terrain was assumed to have no meteorological influences (it was assumed to be flat).

2.2 PCRAMMET Meteorological Processing

The PCRAMMET meteorological data preprocessor was used to translate the hourly meteorological observations from each of the six example locations into a set of meteorological parameters used in CALPUFF. Although CALPUFF has a separate and equivalent processor called CPRAMMET that estimates solar radiation, this step was not required because the SAMSON data already included the solar radiation values.

PCRAMMET requires certain surface characteristics for estimating the dispersion parameters for deposition modeling, including friction velocity, Monin-Obukhov length, relative humidity, and solar radiation. The suggested values for surface roughness (Sheih et al. 1979), noon-time albedo (Iqbal 1983), and Bowen ratio (Paine 1987) are based on the predominant land-use type of a location and vary by season. Each of the selected locations was assigned a land-use type and corresponding average annual value for each of these three surface characteristics, based on information provided by BLM. The suggested values for minimum Monin-Obukhov length (Hanna and Chang 1991), anthropogenic heat flux (Oke 1978), and the fraction of net radiation absorbed at the ground (Oke 1982) were based on assumed rural conditions. All locations used the following assumptions in PCRAMMET: 2 meters (m) minimum Monin-Obukhov length; 0.15 m "measured" surface roughness length; no anthropogenic heat flux; and 0.15 fraction of net radiation absorbed. Table 2-1 summarizes other location characteristics that were used in PCRAMMET.

TABLE 2-1
Location Characteristics used for Input to PCRAMMET

Location Characteristics	LOCATION					
	Fairbanks, Alaska	**Tucson, Arizona**	**Glasgow, Montana**	**Winnemucca, Nevada**	**Medford, Oregon**	**Lander, Wyoming**
Land-Use Type	50% Coniferous 50% Deciduous	Desert shrubland	Grassland	Desert shrubland	Coniferous forest	Desert shrubland
Soil Type	Loam	Sandy loam	Loamy sand	Sandy loam	Loam	Loamy sand
Anemometer height (m)	9.14	6.10	6.10	10.06	6.10	9.75
Surface threshold friction velocity (cm/s)	150.0	290.0	103.0	290.0	150.0	103.0
Applied roughness length (m)	1.10	0.26	0.04	0.26	1.30	0.26
Noon-time albedo	0.20	0.33	0.29	0.33	0.18	0.33
Bowen ratio (average precipitation)	0.85	4.75	0.93	4.75	0.83	4.75

2.3 Placement of Modeled Receptors

Receptors were placed along radials spaced every 10 degrees from approximately 1 km (about 0.6 miles) out to 100 km (about 62 miles) from the center of the modeled treatment area. The distance of the nearest ring of receptors was placed 0.5 km from the edge of the square treatment area, which varied by treatment method as summarized below in Table 2-2. In all, seven receptor grids were developed, differing only in the placement of the nearest ring. Beyond 1.5 km, all receptor grids were identical (with the exception of that for prescribed fire treatment for Fairbanks where the first receptor ring was placed at 1.9 km). Receptors beyond 1.5 km were placed at regular intervals from the center of the treatment area as follows:

- 0.5-km spacing from 1.5 to 3.0 km
- 1.0-km spacing from 3.0 to 10 km
- 2.0-km spacing from 10 to 20 km
- 5.0-km spacing from 20 to 50 km
- 10-km spacing from 50 to 100 km

The radial grid is consistent with general modeling practices described in 40 CFR Part 51, Appendix W and with CALPUFF screening procedures available at: http://www.src.com/calpuff/Screen_Guide.pdf and http://www.epa.gov/scram001/7thconf/calpuff/scrnanl.pdf.

TABLE 2-2
Summary of Receptor Grids used in CALPUFF Modeling

Receptor Grid	Treatment Method	Location	Treatment Area Size (acres)	Distance to Nearest Receptor Ring (m)[1]	Total Number of Receptor Rings	Total Number of Receptors
1	Biological	All 6 Sites	10	601	28	1,008
1	Chemical	All 6 Sites	10	601	28	1,008
2	Manual	All 6 Sites	5	571	28	1,008
3	Mechanical	All 6 Sites	50	725	28	1,008
3	Prescribed fire	Medford, Oregon	50	725	28	1,008
4	Prescribed fire	Glasgow, Montana	500	1,211	28	1,008
4	Prescribed fire	Tucson, Arizona	500	1,211	28	1,008
5	Prescribed fire	Fairbanks, Alaska	2,000	1,922	27	972
6	Prescribed fire	Lander, Wyoming	750	1,371	28	1,008
7	Prescribed fire	Winnemucca, Nevada	700	1,342	28	1,008

[1] Distance from the center of the treatment area.

3.0 EXAMPLE MODELING PROCEDURES FOR EACH OF THE FIVE VEGETATION TREATMENT METHODS

This section provides a description of the procedures and scenarios that were used in the example CALPUFF modeling for assessing TSP, PM_{10}, and $PM_{2.5}$ concentrations from approximately 1 to 100 km downwind of each of the vegetation treatment activity areas. The BLM has provided the general vegetation treatment assumptions, which are listed in Section 3 of the "*Vegetation Treatment Programmatic EIS Air Quality Impact Assessment Protocol*" (hereafter referred to as "the protocol;" ENSR 2005). One example case from the assumptions outlined in the protocol was selected for each of the five treatment methods (prescribed fire, mechanical, manual, biological, and chemical), for each of the six locations. Each case was modeled using the 1-year meteorological databases for six general locations and the procedures described in Section 2.

While the intent of this analysis is to model a general location in each of six states, CALPUFF requires a specific base elevation and specific latitude and longitude coordinates of the center of the modeling domain for calculation of solar elevation angles. The base elevation, latitude, and longitude of each of the six surface meteorological stations were therefore used as the center of each modeling domain.

Figure 3-1 shows the general site layout for each treatment method included in the example modeling, further explained by treatment method below. For modeling purposes, each treatment area (consisting of the number of acres treated per day) was centered within the treatment event site (consisting of the total number of acres treated). Note that the treatment area varies from state to state for prescribed fire, that access road use were not included in Alaska (for prescribed fire only), and that only in Nevada were fuel breaks and road access both included.

3.1 Example Modeling Approach

In accordance with the protocol, emissions from each TSP, PM_{10}, and $PM_{2.5}$ source were calculated for each treatment "event," and then summed to determine the total particulate emissions per event for each of the five treatment methods. The total particulate emissions were then divided by the number of days per event to determine daily TSP, PM_{10}, and $PM_{2.5}$ emissions for each treatment method.

The daily emissions for each method were modeled using CALPUFF "lite" (described in Section 2 above) for a full year to determine the conditions under which maximum air quality impacts are likely to occur, and during which vegetation treatment could take place. The maximum potential impact period was defined as those consecutive days (excluding months when treatment activity is unlikely) during which the highest short-term impacts are predicted to occur. For example, prescribed fire treatment for Glasgow, Montana, is assumed to take place over 5 days. Therefore, the maximum impact period was defined as the 5-day period producing the maximum 5-day average concentration. Once the period of maximum potential impact was established, CALPUFF lite was re-run, with daily emissions occurring only during that period, to determine both short-term and annual impacts for the example treatment method being modeled.

Listed below are the periods of the year where treatment activity was deemed "unlikely" for each location due to winter conditions. These periods were excluded in the determination of the maximum potential impact period. Unlikely treatment days were identified by considering the average first snowfall and latest snowfall dates as well as the mean monthly snowfall amounts in the vicinity of each location, as shown in the "Climate Atlas of the United States" (National Climatic Data Center 2000).

- Fairbanks, Alaska: January 1 – April 15, and October 1 – December 31
- Tucson, Arizona: None, treatment activity considered possible for all days of the year

- Glasgow, Montana: January 1 – April 15 and October 1 – December 31
- Winnemucca, Nevada: January 1 – April 15 and November 1 – December 31
- Medford, Oregon: January 1 – March 15
- Lander, Wyoming: January 1 – May 15, and October 1 - December 31

3.2 Source Parameters for Prescribed Fire

The total particulate emissions per treatment event that were calculated in the emissions inventory were used to determine daily emission rates for each prescribed fire treatment source. Sources that were modeled include fire, unpaved roads used by transportation and ignition vehicles, and fugitive dust occurring from pre/post-treatment fuel-break blading.

For prescribed fire treatment in Nevada, the treatment scenario assumptions provided by BLM include the potential for windblown dust to occur after prescribed fire preparations. The protocol developed with the BLM for this modeling study stated that fugitive dust from the soil would be modeled, assuming that the fugitive dust could be emitted daily for 3 months following the predetermined maximum potential impact period. However, fugitive emissions occurring within three months of the prescribed fire treatment would not have occurred in the modeled year (1985) in Winnemucca, Nevada. One of the restrictions of the protocol stated that hourly particulate emissions are assumed to be zero when the hourly friction velocity is less than the threshold friction velocity. Therefore, fugitive dust occurring after prescribed fires was not modeled in this example.

3.2.1 Fire Treatments

Each fire was treated as a buoyant, square area source in CALPUFF. The size of the area source was set to the number of acres burned per day during each treatment event in each of the six example states (as outlined in Section 3 of the protocol), and the rate of area burned was determined by daily extent of area burned divided by the daily burn duration (24 hr/day in Alaska, and 9 hr/day in all other states).

To model emissions from fire, the daily particulate emission rate, determined from the emissions inventory, was spread over the daily burn duration. Emissions were "turned on" only from 9 a.m. until 6 p.m. for each day modeled for all states except Alaska, where fire was assumed to burn for 24 hours and hence emissions were set to occur all day. Table 3-1 summarizes the fire emission rates used in CALPUFF.

Individual state Fire Behavior Assumptions were provided by the BLM. The remaining necessary buoyant area source input parameters were based on the CALPUFF preprocessor equations (EPM2BAEM; Scire et al. 2000). To use the EPM2BAEM equations, two fire-specific parameters were needed: the heat release rate and the diameter of the fire. The heat release rate was calculated using the heat content per unit area (British Thermal Units per square foot [BTU/ft^2]) provided by the BLM, and the rate of the area burned. The diameter of the fire was determined from the area of the fire (number of acres burned per day). The source data used to model fires as buoyant area sources, as well as the equations that were used to calculate the data, are summarized below. The modeling archive contains calculations for the prescribed fire source data, including the emissions.

(EQN 1)

Heat Release Rate (BTU/s) = Heat per Unit Area (BTU/ft^2) x Rate of Area Burned (ft^2/s)

Buoyant Area Source Input Parameters (from Scire et al. [2000] unless otherwise noted):

- Effective Emission Height of the emissions above the ground is determined through the calculation of a scaled heat release rate, q* (Cetegen et al. 1982):

(EQN 2)

Scaling factor (q^*) = Heat Release Rate (Kilowatts) / (R_{amb} x C_{plume} x T_{amb} x $g^{0.5}$ x $d^{2.5}$)

Where R_{amb} = Ground Air Density at Ambient Temperature (assumed to be 1.24 kg/m^3 at 285 º Kelvin (K) and 1 atmosphere (atm))
C_{plume} = Specific Heat of Plume (assumed to be 1.004 kJ/kg º K)
T_{amb} = Ground Ambient Temperature (assumed to be 285 º K)
g = Gravitational Acceleration Constant (9.8 m/s^2)
d = Diameter of the Fire (m) = 2 x (area of fire (m^2/π))^{½}

If $q^* \leq 0.865$, then
Effective Emission Height (m) = 3.18 x d x $(q^*)^{0.4}$

If $q^* > 0.865$, then
Effective Emission Height (m) = 3.30 x d x $(q^*)^{0.744}$

- Molecular weight of particulate emissions: 200 atomic mass units (amu)
- Release (flame) temperature: T_{flame} (K) = 900 K
- Effective Rise Velocity (assuming conservation of buoyancy flux, proportional to heat release rate): FB (Buoyancy Flux in m^4/s^3) ~ 8.8e-6 x Heat Release Rate (in watts)

(EQN 3)

- Effective Rise Velocity (m/s) = FB x T_{flame} / [g x ($T_{flame} - T_{amb}$) x fire radius]
- Fire radius (m) for effective rise velocity calculation: $r = \sqrt{(\text{area of fire } [m^2]/\pi)}$.
- Initial Vertical Spread: 15.0 m (Sandberg and Peterson 1984)

3.2.2 Unpaved Transportation Roads

Unpaved roads used by transportation vehicles were treated as non-buoyant line sources in CALPUFF. Each line source was assumed to be 15 miles long (yielding a 30 mile round-trip) and 8 feet wide, and assumed to have a mid-point release height of 1 m. For each treatment example, they were oriented from south to north, ending at the southwest corner of the treatment site. It was assumed that the treatment site is a square equal to the number of acres burned in one day at each of the five locations (it was assumed no unpaved roads would be used for the Fairbanks, Alaska).

To determine the maximum number of points used to model the line source, an input variable required by CALPUFF, a simple sensitivity analysis was conducted. The analysis consisted of a series of CALPUFF runs using different numbers of points, which confirmed that this parameter has very little influence on the resulting predicted concentrations. If the number of points used to model the line source is set to a large number such as 100 or 1,000, significantly more computing time is required. Therefore, the parameter was set to 10, which maximized time efficiency. This analysis is documented in the modeling archive.

To model the fugitive dust emissions, the daily particulate emission rate (determined from the emissions inventory) was spread over the number of hours per day the road would be used. It was assumed that travel to/from the site would occur within 1 hour. Emissions were “turned on” only during the 5 a.m. and 6 p.m. hours for each day modeled for Nevada (where fuel break blading occurred 4 hours prior to treatment), and during the 8 a.m. and 6 p.m. hours for each day modeled for all other states. It was assumed that employees would be transported to the site during the hour before treatment (or before pre-treatment for Nevada) and from the site during the hour following treatment. Table 3-1 summarizes the transportation road emission rates used in CALPUFF.

3.2.3 Unpaved Roads used by Ignition Vehicles

Particulate emissions from unpaved roads used by ground ignition vehicles (in Wyoming only) were treated as non-buoyant, square area sources in CALPUFF. The area of the source was assumed to be equal to the area of the fire, and was modeled at a height of 1 m. To simplify the modeling for a multiple-day prescribed burn, the location of each daily burn was assumed to be the same, although the actual burns would likely be in adjacent areas. The initial vertical dispersion coefficient was set to a wheel height of 1 m divided by 2.15, as recommended in the ISCST3 users guide (EPA 1995).

Because the ignition vehicles travel on-site during treatment, daily emissions determined from the emissions inventory were spread over the 9-hour treatment period and "turned on" for the same hours as that for the fire: 9 a.m. until 6 p.m. for each day that was modeled. Table 3-1 summarizes the emission rates for fugitive dust from ignition vehicles used in CALPUFF.

3.2.4 Fuel-break Blading

Fugitive dust occurring during fuel-break blading (in Nevada only) was treated as a non-buoyant line source that surrounds the area to be burned, similar to an unpaved road. The line source was assumed to be 10 feet wide and have a mid-point release height of 1 m. The line was modeled as four segments representing the sides of the square treatment area. Similar to the transportation roads, the number of points used to model each of the segments was set to 10.

Because fuel-break blading occurs prior to treatment, daily emissions determined from the emissions inventory were spread over a 4-hour period prior to the fire treatment period. Emissions were "turned on" only from 5 a.m. through 8 a.m. for each day that was modeled. Table 3-1 summarizes the emission rates for fugitive dust from fuel-break blading used in CALPUFF.

3.3 Mechanical Treatments

The total particulate emissions per mowing treatment event that were calculated in the emissions inventory were used to determine daily emission rates for each mechanical treatment source. Sources that were modeled include onsite operations vehicles (emissions from tractor exhaust plus fugitive dust emissions during drill seeding) and unpaved roads used by transportation vehicles. Blading/piling activities were not included in the example modeling as mowing represents the significant majority of mechanical treatment activities in each of the six states considered. The modeling archive contains emissions calculations for the mechanical treatment sources.

3.3.1 On-site Operations Vehicles

Particulate emissions from tractors used during mowing/drill seeding were treated as non-buoyant, square area sources in CALPUFF. The area of the source was assumed to be equal to the area covered by drill seeding and was modeled at a height of 1 m. The initial vertical dispersion coefficient was set to a wheel height of 1 m divided by 2.15, as per the ISCST3 users guide (EPA 1995).

Because the tractors travel onsite during treatment, daily emissions determined from the emissions inventory were spread over the 8-hour treatment period and "turned on" only from 9 a.m. until 5 p.m. for each day that was modeled. Table 3-2 summarizes the emission rates for particulate emissions from tractors used in CALPUFF.

TABLE 3-1
Hourly Emissions for Prescribed Fire Treatment used in CALPUFF

Pollutant	Location (and daily treatment period)					
	Fairbanks, Alaska (24-Hour)	Tucson, Arizona (9-Hour)	Glasgow, Montana (9-Hour)	Winnemucca, Nevada (9-Hour)	Medford, Oregon (9-Hour)	Lander, Wyoming (9-Hour)
Emissions from Fire – Area Source (g/s)						
TSP	1.07E+04	5.49E+02	2.71E+02	9.22E+02	3.09E+02	9.67E+02
PM_{10}	1.07E+04	5.49E+02	2.71E+02	9.22E+02	3.09E+02	9.67E+02
$PM_{2.5}$	9.49E+03	5.01E+02	2.30E+02	8.42E+02	2.88E+02	8.76E+02
Emissions from Unpaved Transportation Roads – Line Source (g/s)						
TSP	--	1.58E+00	1.09E+00	1.65E+00	4.40E+00	1.17E+00
PM_{10}	--	3.71E-01	2.74E-01	3.89E-01	1.16E+00	2.86E-01
$PM_{2.5}$	--	5.81E-02	3.61E-02	5.43E-02	1.67E-01	3.80E-02
Emissions from Unpaved Roads used by Ignition Vehicles – Area Source (g/s)						
TSP	--	--	--	--	--	1.16E-01
PM_{10}	--	--	--	--	--	4.56E-02
$PM_{2.5}$	--	--	--	--	--	6.60E-02
Emissions From Fuel Break Blading (per segment, during 4-hour pre-treatment period) – Line Source (g/s)						
TSP	--	--	--	1.33E+01	--	--
PM_{10}	--	--	--	1.26E+01	--	--
$PM_{2.5}$	--	--	--	1.27E+01	--	--

3.3.2 Unpaved Transportation Roads

As in the prescribed fire treatment modeling, unpaved roads used by transportation vehicles were treated as non-buoyant line sources in CALPUFF. Each line source was assumed to be 15 miles long (yielding a 30 mile round-trip) and 8 feet wide, and assumed to have a mid-point release height of 1 m. The number of points used to model the line source was set to 10. For each treatment example, the lines were oriented from south to north, ending at the southwest corner of the treatment site. It was assumed that the treatment site is a square equal to the number of acres treated in one day at each of the six locations.

To model the fugitive dust emissions, the daily particulate emission rate (determined from the emissions inventory) was spread over the number of hours per day the road would be used. It was assumed that travel to/from the site would occur within 1 hour. Emissions were “turned on” only during the 8 a.m. and 5 p.m. hours for each day modeled for all states. It was assumed that employees would be transported to the site during the hour before treatment and from the site during the hour following treatment. Table 3-2 summarizes the transportation road emission rates used in CALPUFF.

3.4 Manual Treatments

The total particulate emissions per cutting and clearing manual treatment event that were calculated in the emissions inventory were used to determine daily emission rates for each mechanical treatment source. Sources that were modeled include chainsaws and unpaved roads used by transportation vehicles. Hand pulling/cutting/shoveling activities are considered less significant and were not included in the example modeling. The modeling archive contains emissions calculations for the manual treatment sources.

TABLE 3-2
Hourly Emissions for Mechanical Treatment used in CALPUFF

Pollutant	Location (and daily treatment period)					
	Fairbanks, Alaska (8-Hour)	Tucson, Arizona (8-Hour)	Glasgow, Montana (8-Hour)	Winnemucca, Nevada (8-Hour)	Medford, Oregon (8-Hour)	Lander, Wyoming (8-Hour)
Emissions from Onsite Operations Vehicles – Area Source (g/s)						
TSP	1.27E-01	7.34E-02	4.85E-02	7.34E-01	1.00E-01	5.05E-02
PM_{10}	3.96E-02	2.95E-02	2.51E-02	2.95E-02	3.65E-02	2.54E-02
$PM_{2.5}$	2.21E-02	2.07E-02	2.01E-02	2.07E-02	2.18E-02	2.01E-02
Emissions from Unpaved Transportation Roads – Line Source (g/s)						
TSP	2.25E-01	2.25E-01	1.22E-01	2.25E-01	3.38E-01	1.30E-01
PM_{10}	5.30E-02	5.30E-02	3.04E-02	5.3E-02	8.93E-02	3.18E-02
$PM_{2.5}$	7.41E-03	7.41E-03	4.01E-02	7.41E-02	1.28E-02	4.23E-03

3.4.1 Chainsaws

Exhaust emissions from chainsaws were treated as non-buoyant, square area sources in CALPUFF. The area of the source was assumed to be equal to the number of acres treated during cutting and clearing activities and was modeled at a height of 1 m. The initial vertical dispersion coefficient was set to a height of 1 m divided by 2.15.

Because chainsaws are assumed to be used onsite during treatment, daily emissions determined from the emissions inventory were spread over the 8-hour treatment period and "turned on" only from 9 a.m. until 5 p.m. for each day that was modeled. Table 3-3 summarizes the emission rates for particulate emissions from chainsaw exhaust used in CALPUFF.

3.4.2 Unpaved Transportation Roads

Unpaved roads used by transportation vehicles were treated in the same manner as specified above in Section 3.3.2

3.5 Biological Treatment Example Modeling

The total particulate emissions per treatment event using herbivores that were calculated in the emissions inventory were used to determine daily emission rates for each biological treatment source. Activities related to the hand release of insects were considered negligible and were not included in the example modeling. Biological treatment example modeling was conducted for each of the six locations with the exception of Fairbanks, Alaska, where it is assumed that no biological treatment would take place.

Unpaved roads used by transportation vehicles (including those used for daily operations and pre/post-treatment activities) were the only sources modeled. Unpaved roads used by vehicles during onsite operations were treated as non-buoyant area sources, in the same manner as specified above in Section 3.3.1. Unpaved transportation roads were treated as non-buoyant line sources, in the same manner as specified above in Sections 3.3.2. Table 3-4 summarizes the emission rates for particulate emissions from unpaved roads used in CALPUFF.

TABLE 3-3
Hourly Emissions for Manual Treatment used in CALPUFF

Pollutant	Location (and daily treatment period)					
	Fairbanks, Alaska (8-Hour)	Tucson, Arizona (8-Hour)	Glasgow, Montana (8-Hour)	Winnemucca, Nevada (8-Hour)	Medford, Oregon (8-Hour)	Lander, Wyoming (8-Hour)
Emissions from Chainsaws – Area Source (g/s)						
TSP	4.38E-02	4.38E-02	4.38E-02	4.38E-02	4.38E-02	4.38E-02
PM_{10}	4.38E-02	4.38E-02	4.38E-02	4.38E-02	4.38E-02	4.38E-02
$PM_{2.5}$	4.38E-02	4.38E-02	4.38E-02	4.38E-02	4.38E-02	4.38E-02
Emissions from Unpaved Transportation Roads – Line Source (g/s)						
TSP	6.76E-01	4.51E-01	2.43E-01	4.51E-01	6.76E-01	2.60E-01
PM_{10}	1.79E-01	1.06E-01	6.08E-02	1.06E-02	1.79E-01	6.37E-02
$PM_{2.5}$	2.57E-02	1.48E-02	8.03E-03	1.48E-02	2.57E-02	8.46E-03

TABLE 3-4
Hourly Emissions for Biological Treatment used in CALPUFF

Pollutant	Location (and daily treatment period)				
	Tucson, Arizona (8-Hour)	Glasgow, Montana (8-Hour)	Winnemucca, Nevada (8-Hour)	Medford, Oregon (8-Hour)	Lander, Wyoming (8-Hour)
Emissions from Unpaved Roads during Onsite Travel – Area Source (g/s)					
TSP	1.63E-03	8.77E-04	1.63E-03	2.44E-03	9.38E-04
PM_{10}	3.31E-04	1.89E-04	3.31E-04	5.59E-04	1.98E-04
$PM_{2.5}$	4.48E-05	2.35E-05	4.48E-05	7.90E-05	2.48E-05
Emissions from Unpaved Transportation Roads – Line Source (g/s)					
TSP	2.55E-01	1.38E-01	2.55E-01	3.83E-01	1.47E-01
PM_{10}	6.01E-02	3.45E-02	6.01E-02	1.01E-01	3.61E-02
$PM_{2.5}$	8.39E-03	4.55E-03	8.39E-03	1.46E-02	4.79E-02

3.6 Chemical Treatments

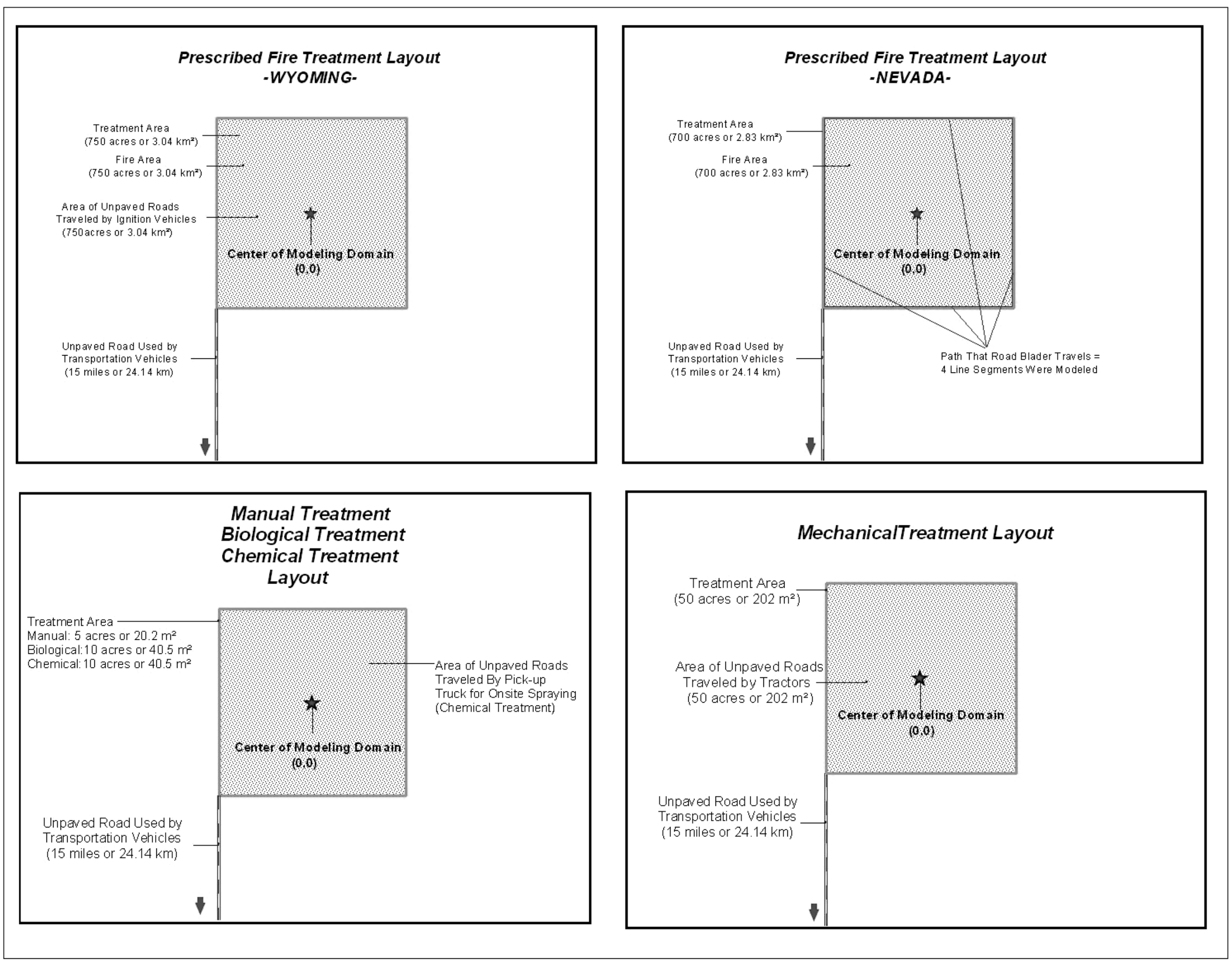
The total particulate emissions per pick-up truck spraying event that were calculated in the emissions inventory were used to determine daily emission rates for each chemical treatment source. Activities related to the airplane and helicopter aerial spraying, all-terrain vehicle (ATV) spraying, and backpack spraying were considered less significant and were not included in the example modeling. Chemical treatment example modeling was conducted for each of the six locations with the exception of Fairbanks, Alaska, where it is assumed that no chemical treatment would take place.

Unpaved roads used during daily operation treatment activities and transportation were the only sources modeled and were treated in the same manner as specified above in Sections 3.3.1 and 3.2.1, respectively. Table 3-5 summarizes the emission rates for particulate emissions from unpaved roads used in CALPUFF.

TABLE 3-5
Hourly Emissions for Chemical Treatment used in CALPUFF

Pollutant	Location (and daily treatment period)				
	Tucson, Arizona (8-Hour)	Glasgow, Montana (8-Hour)	Winnemucca, Nevada (8-Hour)	Medford, Oregon (8-Hour)	Lander, Wyoming (8-Hour)
Emissions from Unpaved Roads during Onsite Travel – Area Source (g/s)					
TSP	1.08E-01	5.82E-02	1.08E-01	1.62E-01	6.22E-02
PM_{10}	2.02E-02	1.15E-02	2.02E-02	3.41E-02	1.20E-02
$PM_{2.5}$	2.66E-03	1.35E-03	2.66E-03	4.75E-03	1.44E-03
Emissions from Unpaved Transportation Roads – Line Source (g/s)					
TSP	4.51E-01	2.43E-01	4.51E-01	6.76E-01	2.60E-01
PM_{10}	1.06E-01	6.08E-02	1.06E-01	1.79E-01	6.37E-02
$PM_{2.5}$	1.48E-02	8.03E-03	1.48E-02	2.57E-02	8.46E-03

Figure 3-1 Layouts for Example Modeling of the Five Vegetation Treatment Methods.



4.0 EXAMPLE MODELING RESULTS

4.1 Determination of the Maximum Potential Impact Period

CALPUFF lite was run for a full year (excluding unlikely treatment periods) for each of the treatment methods and locations to determine the conditions under which maximum air quality impacts are likely to occur and during which vegetation treatment could take place. As stated in Section 3.1, this period was defined as those consecutive days during which the highest short-term impacts are predicted to occur. Table 4-1 summarizes the maximum potential impact period found through preliminary modeling for each location and treatment method.

TABLE 4-1
Maximum Potential Impact Period for each Location and Treatment Method

Location	Treatment Method	Averaging Period (days)[1]	Maximum Potential Impact Period (days)[2]
Fairbanks, Alaska	Manual treatment	5	258-262
	Mechanical treatment	2	256-257
	Prescribed fire treatment	5	259-263
Tucson, Arizona	Biological treatment	30	24-53
	Chemical treatment	1	25
	Manual treatment	5	344-348
	Mechanical treatment	2	345-346
	Prescribed fire treatment	4	360-363
Glasgow, Montana	Biological treatment	30	114-132
	Chemical treatment	1	115
	Manual treatment	5	112-116
	Mechanical treatment	2	113-114
	Prescribed fire treatment	5	133-137
Winnemucca, Nevada	Biological treatment	30	274-303
	Chemical treatment	1	245
	Manual treatment	5	240-244
	Mechanical treatment	2	243-244
	Prescribed fire treatment	6	120-125
Medford, Oregon	Biological treatment	30	333-362
	Chemical treatment	1	292
	Manual treatment	5	290-294
	Mechanical treatment	2	290-291
	Prescribed fire treatment	2	355-356
Lander, Wyoming	Biological treatment	30	231-260
	Chemical treatment	1	244
	Manual treatment	5	242-246
	Mechanical treatment	2	242-243
	Prescribed fire treatment	4	209-212

[1] Averaging period is equivalent to the number of days per treatment event.
[2] Listed as Julian days of the year.

4.2 CALPUFF Lite Results

To determine both short-term and annual air concentrations for each of the example treatment methods, particulate emissions were "turned on" only for the days listed above for specific hours of the day, as noted above in Section 3. Table 4-2 provides the CALPUFF lite results for all locations.

4.3 National Ambient Air Quality Standards Compliance Analysis

In addition to determining the predicted air concentrations due to each treatment method, the short-term and annual air quality impacts were assessed with respect to the NAAQS. The air concentrations predicted by CALPUFF lite were added to a representative rural background concentration and then compared to the NAAQS to determine if the treatment methods would contribute to any NAAQS violations.

4.3.1 Representative Background Concentration

To compare modeled particulate concentrations due to each treatment method to the NAAQS, a regional background concentration is needed to represent ambient particulate concentrations due to background sources in the vicinity of the treatment area. Each of the six states have a network of monitors measuring the levels of criteria pollutants in various areas, however most monitors are in populated areas, as public exposure to criteria pollutants is of particular interest. This analysis assumed that vegetation treatment takes place in rural areas, therefore concentrations measures at most monitors would yield an overly conservative estimate of ambient particulate concentrations in the vicinity of the treatment areas.

For areas where site-specific background values are not available (rural areas), both Montana and New Mexico identify representative background values that can be used for NAAQS analyses. The New Mexico Air Quality Bureau (1998) indicates appropriate background PM_{10} values in Figure 4 of its *New Mexico Air Quality Bureau Dispersion Modeling Guidelines*. The figure specifies a maximum PM_{10} concentration of 30 $\mu g/m^3$ in rural areas. It is also noted that TSP background concentrations can be calculated by multiplying the PM_{10} concentration by 1.33. The guidelines do not specify a separate set of values for annual impacts.

The *Montana Modeling Guideline for Air Quality Permits* (Montana Department of Environmental Quality [MDEQ] 2002:Table 6-1) identifies PM_{10} background values to be added to modeling concentrations where all significant local sources have been included. The guideline indicates 30 $\mu g/m^3$ and 8 $\mu g/m^3$ are appropriate for the 24-hour and annual averaging periods, respectively.

For the purposes of this NAAQS analysis, the following were used as representative rural background concentrations:

- TSP 24-hour: 40 $\mu g/m^3$
- TSP Annual: 11$\mu g/m^3$
- PM_{10} 24-hour: 30 $\mu g/m^3$
- PM_{10} Annual: 8 $\mu g/m^3$
- $PM_{2.5}$ 24-hour: 30 $\mu g/m^3$
- $PM_{2.5}$ Annual: 8 $\mu g/m^3$

The TSP concentrations are 1.33 times the PM_{10} concentrations. PM_{10} background concentrations were conservatively assumed for $PM_{2.5}$.

TABLE 4-2
CALPUFF Lite Modeling Results

Location	Pollutant	Averaging Period	CALPUFF Lite Modeling Results[1] (μg/m³)				
			Biological Treatment	Chemical Treatment	Manual Treatment	Mechanical Treatment	Prescribed Fire Treatment
Fairbanks, Alaska	TSP	24-hour	-	-	1.37E-01	1.77E-01	37.82
		Annual	-	-	1.13E-03	9.24E-04	4.36E-01
	PM_{10}	24-hour	-	-	1.37E-01	5.53E-02	37.82
		Annual	-	-	1.12E-03	2.88E-04	4.36E-01
	$PM_{2.5}$	24-hour	-	-	1.37E-01	3.08E-02	33.54
		Annual	-	-	1.12E-03	1.61E-04	3.87E-01
Tucson, Arizona	TSP	24-hour	1.83E-01	2.93E-03	7.31E-02	8.45E-02	2.81E-01
		Annual	5.12E-04	8.02E-06	2.03E-04	2.32E-04	1.14E-03
	PM_{10}	24-hour	4.31E-02	5.47E-04	7.31E-02	3.40E-02	2.81E-01
		Annual	1.21E-04	1.50E-06	2.01E-04	9.32E-05	1.14E-03
	$PM_{2.5}$	24-hour	6.02E-03	7.21E-05	7.31E-02	2.38E-02	2.56E-01
		Annual	1.68E-05	1.97E-07	2.01E-04	6.54E-05	1.04E-03
Glasgow, Montana	TSP	24-hour	2.36E-02	1.16E-03	6.95E-02	4.15E-02	3.58E-01
		Annual	6.94E-05	3.19E-06	1.95E-04	1.14E-04	1.14E-03
	PM_{10}	24-hour	5.90E-03	2.36E-04	5.80E-02	1.96E-02	3.58E-01
		Annual	1.74E-05	6.48E-07	1.76E-04	5.38E-05	1.14E-03
	$PM_{2.5}$	24-hour	7.78E-04	2.82E-05	5.60E-02	1.46E-02	3.03E-01
		Annual	2.29E-06	7.74E-08	1.70E-04	3.99E-05	9.63E-04
Winnemucca, Nevada	TSP	24-hour	7.93E-03	1.42E-03	3.583E-02	3.53E-02	3.19E-01
		Annual	6.01E-05	3.90E-06	1.007E-04	9.69E-05	8.85E-04
	PM_{10}	24-hour	1.86E-03	2.72E-04	3.32E-02	1.40E-02	3.19E-01
		Annual	1.42E-05	7.44E-07	9.16E-05	3.84E-05	8.86E-04
	$PM_{2.5}$	24-hour	2.59E-04	3.60E-05	3.25E-02	9.68E-03	2.91E-01
		Annual	1.98E-06	9.85E-08	8.92E-05	2.65E-05	8.08E-04
Medford, Oregon	TSP	24-hour	2.14E-01	3.86E-02	1.58E-01	1.82E-01	1.31
		Annual	6.46E-04	1.07E-04	4.62E-04	5.30E-04	6.21E-03
	PM_{10}	24-hour	5.65E-02	8.20E-03	1.18E-01	6.61E-02	1.31
		Annual	1.70E-04	2.28E-05	3.58E-04	1.92E-04	6.18E-03
	$PM_{2.5}$	24-hour	8.17E-03	1.14E-03	1.17E-01	3.90E-02	1.22
		Annual	2.46E-05	3.19E-06	3.50E-04	1.14E-04	5.76E-03
Lander, Wyoming	TSP	24-hour	3.81E-03	6.60E-04	8.85E-03	7.35E-03	2.44E-01
		Annual	1.97E-05	1.81E-06	2.59E-05	2.08E-05	6.80E-04
	PM_{10}	24-hour	9.35E-04	1.37E-04	8.06E-03	3.27E-03	2.44E-01
		Annual	4.84E-06	3.75E-07	2.32E-05	9.20E-06	6.77E-04
	$PM_{2.5}$	24-hour	1.24E-04	1.72E-05	7.84E-03	2.50E-03	2.21E-01
		Annual	6.43E-07	4.70E-08	2.24E-05	6.98E-06	6.13E-04

[1]Because of the variation in the number of treatment days for each method, the maximum 24-hour concentrations are listed in lieu of high second high or 98th percentile concentrations. Reporting the maximum concentrations also adds a level of conservatism to the modeling results.

4.3.2 Results of National Ambient Air Quality Standards Analysis

CALPUFF lite results from Table 4-2 were added to the background concentrations noted above and compared to the NAAQS for each location and treatment method as shown in Tables 4-3 through 4-7. Because no air quality standards are available for TSP, the NAAQS for PM_{10} was conservatively assumed for TSP. The tables indicate that particulate emissions due to each of the five vegetation treatments would not cause or significantly contribute to a NAAQS violation at any of the six locations, given the assumptions of this analysis.

TABLE 4-3
National Ambient Air Quality Standards Compliance Analysis for Prescribed Fire Treatment

Location	Pollutant	Averaging Period	CALPUFF Lite Concentration ($\mu g/m^3$)	Background Concentration[1] ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	NAAQS Standard[2] ($\mu g/m^3$)
Fairbanks, Alaska	TSP	24-hour	37.82	40	77.82	150
		Annual	4.36E-01	11	11.44	50
	PM_{10}	24-hour	37.82	30	67.82	150
		Annual	4.36E-01	8	8.44	50
	$PM_{2.5}$	24-hour	33.54	30	63.54	65
		Annual	3.87E-01	8	8.39	15
Tucson, Arizona	TSP	24-hour	2.81E-01	40	40.28	150
		Annual	1.14E-03	11	11.00	50
	PM10	24-hour	2.81E-01	30	30.28	150
		Annual	1.14E-03	8	8.00	50
	PM2.5	24-hour	2.56E-01	30	30.26	65
		Annual	1.04E-03	8	8.00	15
Glasgow, Montana	TSP	24-hour	3.58E-01	40	40.36	150
		Annual	1.14E-03	11	11.00	50
	PM10	24-hour	3.58E-01	30	30.36	150
		Annual	1.14E-03	8	8.00	50
	PM2.5	24-hour	3.03E-01	30	30.30	65
		Annual	9.63E-04	8	8.00	15
Winnemucca, Nevada	TSP	24-hour	3.19E-01	40	40.32	150
		Annual	8.85E-04	11	11.00	50
	PM10	24-hour	3.19E-01	30	30.32	150
		Annual	8.86E-04	8	8.00	50
	PM2.5	24-hour	2.91E-01	30	30.29	65
		Annual	8.08E-04	8	8.00	15
Medford, Oregon	TSP	24-hour	1.31	40	41.31	150
		Annual	6.21E-03	11	11.01	50
	PM10	24-hour	1.31	30	31.31	150
		Annual	6.18E-03	8	8.01	50
	PM2.5	24-hour	1.22	30	31.22	65
		Annual	5.76E-03	8	8.01	15
Lander, Wyoming	TSP	24-hour	2.44E-01	40	40.24	150
		Annual	6.80E-04	11	11.00	50
	PM10	24-hour	2.44E-01	30	30.24	150
		Annual	6.77E-04	8	8.00	50
	PM2.5	24-hour	2.21E-01	30	30.22	65
		Annual	6.13E-04	8	8.00	15

[1] PM_{10} Data from Table 6.1 of the *Montana Modeling Guideline for Air Quality Permits* (MDEQ 2002). Total suspended particles concentrations calculated by multiplying PM_{10} data by 1.33. PM_{10} concentrations are also conservatively used as background concentrations for $PM_{2.5}$.
[2] No standards are available for TSP, therefore those for PM_{10} were conservatively assumed for TSP.

TABLE 4-4
National Ambient Air Quality Standards Compliance Analysis for Mechanical Treatment

Location	Pollutant	Averaging Period	CALPUFF Lite Concentration ($\mu g/m^3$)	Background Concentration[1] ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	NAAQS Standard[2] ($\mu g/m^3$)
Fairbanks, Alaska	TSP	24-hour	1.77E-01	40	40.18	150
		Annual	9.24E-04	11	11.00	50
	PM_{10}	24-hour	5.53E-02	30	30.06	150
		Annual	2.88E-04	8	8.00	50
	$PM_{2.5}$	24-hour	3.08E-02	30	30.03	65
		Annual	1.61E-04	8	8.00	15
Tucson, Arizona	TSP	24-hour	8.45E-02	40	40.08	150
		Annual	2.32E-04	11	11.00	50
	PM10	24-hour	3.40E-02	30	30.03	150
		Annual	9.32E-05	8	8.00	50
	PM2.5	24-hour	2.38E-02	30	30.02	65
		Annual	6.54E-05	8	8.00	15
Glasgow, Montana	TSP	24-hour	4.15E-02	40	40.04	150
		Annual	1.14E-04	11	11.00	50
	PM10	24-hour	1.96E-02	30	30.02	150
		Annual	5.38E-05	8	8.00	50
	PM2.5	24-hour	1.46E-02	30	30.01	65
		Annual	3.99E-05	8	8.00	15
Winnemucca, Nevada	TSP	24-hour	3.53E-02	40	40.04	150
		Annual	9.69E-05	11	11.00	50
	PM10	24-hour	1.40E-02	30	30.01	150
		Annual	3.84E-05	8	8.00	50
	PM2.5	24-hour	9.68E-03	30	30.01	65
		Annual	2.65E-05	8	8.00	15
Medford, Oregon	TSP	24-hour	1.82E-01	40	40.18	150
		Annual	5.30E-04	11	11.00	50
	PM10	24-hour	6.61E-02	30	30.07	150
		Annual	1.92E-04	8	8.00	50
	PM2.5	24-hour	3.90E-02	30	30.04	65
		Annual	1.14E-04	8	8.00	15
Lander, Wyoming	TSP	24-hour	7.35E-03	40	40.01	150
		Annual	2.08E-05	11	11.00	50
	PM10	24-hour	3.27E-03	30	30.00	150
		Annual	9.20E-06	8	8.00	50
	PM2.5	24-hour	2.50E-03	30	30.00	65
		Annual	6.98E-06	8	8.00	15

[1] PM_{10} Data from Table 6.1 of the *Montana Modeling Guideline for Air Quality Permits* (MDEQ 2002). Total suspended particles concentrations calculated by multiplying PM_{10} data by 1.33. PM_{10} concentrations are also conservatively used as background concentrations for $PM_{2.5}$.
[2] No standards are available for TSP, therefore those for PM_{10} were conservatively assumed for TSP.

TABLE 4-5
National Ambient Air Quality Standards Compliance Analysis for Manual Treatment

Location	Pollutant	Averaging Period	CALPUFF Lite Concentration (μg/m³)	Background Concentration[1] (μg/m³)	Total Concentration (μg/m³)	NAAQS Standard[2] (μg/m³)
Fairbanks, Alaska	TSP	24-hour	1.37E-01	40	40.14	150
		Annual	1.13E-03	11	11.00	50
	PM_{10}	24-hour	1.37E-01	30	30.14	150
		Annual	1.12E-03	8	8.00	50
	$PM_{2.5}$	24-hour	1.37E-01	30	30.14	65
		Annual	1.12E-03	8	8.00	15
Tucson, Arizona	TSP	24-hour	7.31E-02	40	40.07	150
		Annual	2.03E-04	11	11.00	50
	PM10	24-hour	7.31E-02	30	30.07	150
		Annual	2.01E-04	8	8.00	50
	PM2.5	24-hour	7.31E-02	30	30.07	65
		Annual	2.01E-04	8	8.00	15
Glasgow, Montana	TSP	24-hour	6.95E-02	40	40.07	150
		Annual	1.95E-04	11	11.00	50
	PM10	24-hour	5.80E-02	30	30.06	150
		Annual	1.76E-04	8	8.00	50
	PM2.5	24-hour	5.60E-02	30	30.06	65
		Annual	1.70E-04	8	8.00	15
Winnemucca, Nevada	TSP	24-hour	3.583E-02	40	40.04	150
		Annual	1.007E-04	11	11.00	50
	PM10	24-hour	3.32E-02	30	30.03	150
		Annual	9.16E-05	8	8.00	50
	PM2.5	24-hour	3.25E-02	30	30.03	65
		Annual	8.92E-05	8	8.00	15
Medford, Oregon	TSP	24-hour	1.58E-01	40	40.16	150
		Annual	4.62E-04	11	11.00	50
	PM10	24-hour	1.18E-01	30	30.12	150
		Annual	3.58E-04	8	8.00	50
	PM2.5	24-hour	1.17E-01	30	30.12	65
		Annual	3.50E-04	8	8.00	15
Lander, Wyoming	TSP	24-hour	8.85E-03	40	40.01	150
		Annual	2.59E-05	11	11.00	50
	PM10	24-hour	8.06E-03	30	30.01	150
		Annual	2.32E-05	8	8.00	50
	PM2.5	24-hour	7.84E-03	30	30.01	65
		Annual	2.24E-05	8	8.00	15

[1] PM_{10} Data from Table 6.1 of the *Montana Modeling Guideline for Air Quality Permits* (MDEQ 2002). Total suspended particles concentrations calculated by multiplying PM_{10} data by 1.33. PM_{10} concentrations are also conservatively used as background concentrations for $PM_{2.5}$.
[2] No standards are available for TSP, therefore those for PM_{10} were conservatively assumed for TSP.

TABLE 4-6
National Ambient Air Quality Standards Compliance Analysis for Biological Treatment

Location	Pollutant	Averaging Period	CALPUFF Lite Concentration (μg/m³)	Background Concentration[1] (μg/m³)	Total Concentration (μg/m³)	NAAQS Standard[2] (μg/m³)
Fairbanks, Alaska	TSP	24-hour	-	40	40.00	150
		Annual	-	11	11.00	50
	PM_{10}	24-hour	-	30	30.00	150
		Annual	-	8	8.00	50
	$PM_{2.5}$	24-hour	-	30	30.00	65
		Annual	-	8	8.00	15
Tucson, Arizona	TSP	24-hour	1.83E-01	40	40.18	150
		Annual	5.12E-04	11	11.00	50
	PM10	24-hour	4.31E-02	30	30.04	150
		Annual	1.21E-04	8	8.00	50
	PM2.5	24-hour	6.02E-03	30	30.01	65
		Annual	1.68E-05	8	8.00	15
Glasgow, Montana	TSP	24-hour	2.36E-02	40	40.02	150
		Annual	6.94E-05	11	11.00	50
	PM10	24-hour	5.90E-03	30	30.01	150
		Annual	1.74E-05	8	8.00	50
	PM2.5	24-hour	7.78E-04	30	30.00	65
		Annual	2.29E-06	8	8.00	15
Winnemucca, Nevada	TSP	24-hour	7.93E-03	40	40.01	150
		Annual	6.01E-05	11	11.00	50
	PM10	24-hour	1.86E-03	30	30.00	150
		Annual	1.42E-05	8	8.00	50
	PM2.5	24-hour	2.59E-04	30	30.00	65
		Annual	1.98E-06	8	8.00	15
Medford, Oregon	TSP	24-hour	2.14E-01	40	40.21	150
		Annual	6.46E-04	11	11.00	50
	PM10	24-hour	5.65E-02	30	30.06	150
		Annual	1.70E-04	8	8.00	50
	PM2.5	24-hour	8.17E-03	30	30.01	65
		Annual	2.46E-05	8	8.00	15
Lander, Wyoming	TSP	24-hour	3.81E-03	40	40.00	150
		Annual	1.97E-05	11	11.00	50
	PM10	24-hour	9.35E-04	30	30.00	150
		Annual	4.84E-06	8	8.00	50
	PM2.5	24-hour	1.24E-04	30	30.00	65
		Annual	6.43E-07	8	8.00	15

[1] PM_{10} Data from Table 6.1 of the *Montana Modeling Guideline for Air Quality Permits* (MDEQ 2002). Total suspended particles concentrations calculated by multiplying PM_{10} data by 1.33. PM_{10} concentrations are also conservatively used as background concentrations for $PM_{2.5}$.
[2] No standards are available for TSP, therefore those for PM_{10} were conservatively assumed for TSP.

TABLE 4-7
National Ambient Air Quality Standards Compliance Analysis for Chemical Treatment

Location	Pollutant	Averaging Period	CALPUFF Lite Concentration (µg/m³)	Background Concentration[1] (µg/m³)	Total Concentration (µg/m³)	NAAQS Standard[2] (µg/m³)
Fairbanks, Alaska	TSP	24-hour	-	40	40.00	150
		Annual	-	11	11.00	50
	PM_{10}	24-hour	-	30	30.00	150
		Annual	-	8	8.00	50
	$PM_{2.5}$	24-hour	-	30	30.00	65
		Annual	-	8	8.00	15
Tucson, Arizona	TSP	24-hour	2.93E-03	40	40.00	150
		Annual	8.02E-06	11	11.00	50
	PM10	24-hour	5.47E-04	30	30.00	150
		Annual	1.50E-06	8	8.00	50
	PM2.5	24-hour	7.21E-05	30	30.00	65
		Annual	1.97E-07	8	8.00	15
Glasgow, Montana	TSP	24-hour	1.16E-03	40	40.00	150
		Annual	3.19E-06	11	11.00	50
	PM10	24-hour	2.36E-04	30	30.00	150
		Annual	6.48E-07	8	8.00	50
	PM2.5	24-hour	2.82E-05	30	30.00	65
		Annual	7.74E-08	8	8.00	15
Winnemucca, Nevada	TSP	24-hour	1.42E-03	40	40.00	150
		Annual	3.90E-06	11	11.00	50
	PM10	24-hour	2.72E-04	30	30.00	150
		Annual	7.44E-07	8	8.00	50
	PM2.5	24-hour	3.60E-05	30	30.00	65
		Annual	9.85E-08	8	8.00	15
Medford, Oregon	TSP	24-hour	3.86E-02	40	40.04	150
		Annual	1.07E-04	11	11.00	50
	PM10	24-hour	8.20E-03	30	30.01	150
		Annual	2.28E-05	8	8.00	50
	PM2.5	24-hour	1.14E-03	30	30.00	65
		Annual	3.19E-06	8	8.00	15
Lander, Wyoming	TSP	24-hour	6.60E-04	40	40.00	150
		Annual	1.81E-06	11	11.00	50
	PM10	24-hour	1.37E-04	30	30.00	150
		Annual	3.75E-07	8	8.00	50
	PM2.5	24-hour	1.72E-05	30	30.00	65
		Annual	4.70E-08	8	8.00	15

[1] PM_{10} Data from Table 6.1 of the *Montana Modeling Guideline for Air Quality Permits* (MDEQ 2002). Total suspended particles concentrations calculated by multiplying PM_{10} data by 1.33. PM_{10} concentrations are also conservatively used as background concentrations for $PM_{2.5}$.
[2] No standards are available for TSP, therefore those for PM_{10} were conservatively assumed for TSP.

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